2. Gardiner CH, Schantz PM. Mammomonogamus infection in a human: report of a case. *Am J Trop Med Hyg* 1983; **32:** 995–7.
3. Leers WD, *et al.* Syngamosis, an unusual cause of asthma: the first reported case in Canada. *Can Med Assoc J* 1985; **132:** 269–70.
4. Nosanchuk JS, *et al.* Case report of and description of parasite in Mammomonogamus laryngeus (human syngamosis) infection. *J Clin Microbiol* 1995; **33:** 998–1000.
5. Turner P, *et al.* A case of human syngamosis. *Travel Med Infect Dis* 2003; **1:** 231–3.
6. Castaño JC, *et al.* Reporte del primer caso humano de infección parasitaria por Mammomonogamus laryngeus en Colombia. *Biomedica* 2006; **26:** 337–41.

Taeniasis

Taeniasis is an infection of the intestine with beef tapeworm, *Taenia saginata*, or pork tapeworm, *T. solium*, acquired through ingestion of contaminated raw or undercooked meat. The larval form of *T. solium* can cause the systemic infection cysticercosis (see above).

Infection with the adult worm usually produces symptoms only when the worm reaches a size that can cause obstruction or related problems. Segments of the worm containing eggs may be excreted in the faeces so maintaining the cycle of reproduction. Treatment is with a single dose of praziquantel,[1] which has the advantage of also being active, in higher doses, against the larval form of *T. solium*. Niclosamide is also effective but is only active against adult worms.

1. Abramowicz M, ed. *Drugs for parasitic infections*. 1st ed. New Rochelle NY: The Medical Letter, 2007.

Toxocariasis

Toxocariasis[1] is infection with the larval form of *Toxocara canis* or, less commonly, *T. cati*. The adult worms live in the intestines of dogs and cats respectively, and man becomes infected when eggs excreted in animal faeces are ingested. Once ingested the eggs hatch and the larvae migrate from the intestine to other organs, most commonly the liver, lung, and eye. Most infections are asymptomatic but two clinical syndromes, ocular larva migrans and visceral larva migrans, can occur, usually in children.

Ocular larva migrans occurs when larvae invade the eye causing a granuloma which may impair vision and can cause blindness. There is no specific treatment.[2] Anthelmintics such as albendazole or tiabendazole, corticosteroids, ocular surgery, and laser photocoagulation have been used but assessment of their efficacy is difficult because of the variable natural course of the disease.

The clinical symptoms of visceral larva migrans depend upon the organs involved but commonly include cough, wheezing, fever, and hepatomegaly. Encephalitis and seizures may occur and there is usually eosinophilia. Acute infection normally resolves without treatment.[3] However, severe or prolonged infections may be treated with albendazole;[4] mebendazole or tiabendazole have also been used.[1,4]

1. Despommier D. Toxocariasis: clinical aspects, epidemiology, medical ecology, and molecular aspects. *Clin Microbiol Rev* 2003; **16:** 265–72.
2. Shields JA. Ocular toxocariasis: a review. *Surv Ophthalmol* 1984; **28:** 361–81.
3. Gillespie SH. Human toxocariasis. *Commun Dis Rep* 1993; **3:** R140–R143.
4. Abramowicz M, ed. *Drugs for parasitic infections*. 1st ed. New Rochelle NY: The Medical Letter, 2007.

Trichinosis

Trichinosis (trichinellosis) is an infection caused by *Trichinella spiralis*. Man becomes infected through ingestion of raw or undercooked meat, usually pork, containing infective larvae. The larvae mature into adult worms in the small intestine and the mature females deposit larvae which migrate in the blood to skeletal muscle and sometimes to the myocardium. Symptoms usually occur only in heavy infections. Invasion of the intestines by the maturing adult worms can cause diarrhoea, abdominal pain, and vomiting followed about a week later by hypersensitivity reactions to the migrating larvae. These may include eosinophilia, fever, muscle pain, periorbital oedema and, more rarely, encephalitis, myocarditis, or pneumonia which may be fatal.

All patients with confirmed or suspected infection should be treated to prevent the continued production of larvae. Albendazole or mebendazole are considered to be the anthelmintics of choice. A corticosteroid should be given for severe hypersensitivity reactions.[1]

1. Abramowicz M, ed. *Drugs for parasitic infections*. 1st ed. New Rochelle NY: The Medical Letter, 2007.

Trichostrongyliasis

Trichostrongyliasis is an infection of the small intestine caused by *Trichostrongylus* spp. including *T. colubriformis*. *Trichostrongylus* spp. are normally parasites of herbivores, but infections in man have been found. They have a similar life cycle to *Ancylostoma duodenale* (see Hookworm Infections, above). Pyrantel embonate, albendazole, or mebendazole are recommended for the treatment of trichostrongyliasis.[1] Successful treatment with ivermectin has occurred in areas where widespread use of benzimidazole carbamate derivatives in grazing animals has led to resistance to these drugs.[2]

1. Abramowicz M, ed. *Drugs for parasitic infections*. 1st ed. New Rochelle NY: The Medical Letter, 2007.
2. Ralph A, *et al.* Abdominal pain and eosinophilia in suburban goat keepers. *Med J Aust* 2006; **184:** 467–9. Correction. *ibid.*; **185:** 49. [title]

Trichuriasis

Trichuriasis is an infection of the large intestine with *Trichuris trichiura*, sometimes known as whipworm. Distribution is worldwide, but most infections occur in the tropics and subtropics. Eggs are excreted in the faeces and can remain viable in the soil for extended periods. Under optimum conditions the eggs become infective in about 2 to 4 weeks. After ingestion, larvae are released from the eggs and develop within the wall of the small intestine for about 3 to 10 days, before migrating to the lumen of the large intestine where they remain attached to the mucosal lining. Eggs are detectable in the faeces about 1 to 3 months after infection. Trichuriasis is often asymptomatic, but heavy infection can result in anaemia, diarrhoea, and rectal prolapse.

Treatment is with a benzimidazole carbamate derivative such as albendazole or mebendazole[1-3] and such broad-spectrum therapy can be useful if the patient is suffering from a mixed intestinal nematode infection. Ivermectin[2] and nitazoxanide[4] are alternatives. However, a systematic review[3] considered the treatment of trichuriasis to be unsatisfactory with current drugs.

1. Bethony J, *et al.* Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm. *Lancet* 2006; **367:** 1521–32.
2. Abramowicz M, ed. *Drugs for parasitic infections*. 1st ed. New Rochelle NY: The Medical Letter, 2007.
3. Keiser J, Utzinger J. Efficacy of current drugs against soil-transmitted helminth infections: systematic review and meta-analysis. *JAMA* 2008; **299:** 1937–48.
4. Juan JO, *et al.* Comparative clinical studies of nitazoxanide, albendazole and praziquantel in the treatment of ascariasis, trichuriasis and hymenolepiasis in children from Peru. *Trans R Soc Trop Med Hyg* 2002; **96:** 193–6.

Abamectin *(USAN, rINN)*

Abamectina; Abamectine; Abamectinum; MK-0936. A mixture of abamectin component B_{1a} and abamectin component B_{1b}.

Абамектин

CAS — 65195-55-3 (component B_{1a}); 65195-56-4 (component B_{1b}).

ATC Vet — QP54AA02.

Profile

Abamectin is an avermectin anthelmintic used in veterinary medicine for nematode infections. It is also used as a systemic veterinary ectoparasiticide.

Albendazole *(BAN, USAN, rINN)*

Albendatsoli; Albendazol; Albendazolas; Albendazolum; SKF-62979. Methyl 5-propylthio-1*H*-benzimidazol-2-ylcarbamate.

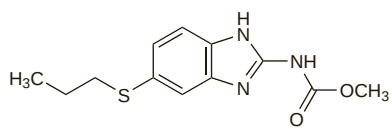
Альбендазол

$C_{12}H_{15}N_3O_2S$ = 265.3.

CAS — 54965-21-8.

ATC — P02CA03.

ATC Vet — QP52AC11.



Pharmacopoeias. In *Chin.*, *Eur.* (see p.vii), *Int.*, *US*, and *Viet.*

Ph. Eur. 6.2 (Albendazole). A white to faintly yellowish powder. Practically insoluble in water and in alcohol; very slightly soluble in dichloromethane; freely soluble in anhydrous formic acid. Protect from light.

USP 31 (Albendazole). A white to faintly yellowish powder. Practically insoluble in water and in alcohol; very slightly soluble in ether and in dichloromethane; freely soluble in anhydrous formic acid. Store in airtight containers.

Adverse Effects and Precautions

As for Mebendazole, p.148.

Incidence of adverse effects. Although generally well-tolerated, the following adverse reactions were reported in the first phase of WHO-coordinated studies[1] involving 30 patients given *high-dose* therapy with albendazole for the treatment of cystic echinococcosis (hydatid disease): raised serum-transaminase levels (2 patients), reduced leucocyte counts (1), gastrointestinal symptoms (1), allergic conditions (1), and loss of hair (1). Treatment was stopped in a further patient with alveolar echinococcosis because of depressed bone-marrow activity. In the second phase of these studies,[2] of 109 patients given albendazole for cystic echinococcosis, 20 had adverse effects; similar findings were reported with mebendazole. The range of effects with albendazole was: elevation of transaminases (5 patients), abdominal pain and other gastrointestinal symptoms (7), severe headache (4), loss of hair (2), leucopenia (2), fever and fatigue (1), thrombocytopenia (1), and urticaria and itching (1). Albendazole had to be withdrawn in 5 patients because of adverse effects, although in 3 the withdrawal was only temporary.

1. Davis A, *et al.* Multicentre clinical trials of benzimidazolecarbamates in human echinococcosis. *Bull WHO* 1986; **64:** 383–8.
2. Davis A, *et al.* Multicentre clinical trials of benzimidazolecarbamates in human cystic echinococcosis (phase 2). *Bull WHO* 1989; **67:** 503–8.

Effects on growth. A multiple-dose regimen of albendazole in children with asymptomatic trichuriasis has been reported to be associated with impaired growth in those with low levels of infection.[1] However it was considered that this should not prevent the use of single doses in mass treatment programmes.[2]

1. Forrester JE, *et al.* Randomised trial of albendazole and pyrantel in symptomless trichuriasis in children. *Lancet* 1998; **352:** 1103–8.
2. Winstanley P. Albendazole for mass treatment of asymptomatic trichuris infections. *Lancet* 1998; **352:** 1080–1.

Effects on the liver. In a series of 40 patients given albendazole for echinococcosis, 7 developed abnormalities in liver function tests during therapy.[1] Six had a hepatocellular type of abnormality attributable to albendazole; the seventh had cholestatic jaundice which was probably not due to albendazole. See also Incidence of Adverse Effects, above for reports of raised serum-transaminase levels.

Albendazole should only be used in the treatment of echinococcosis if there is constant medical supervision with regular monitoring of serum-transaminase concentrations and of leucocyte and platelet counts. Patients with liver damage should be treated with reduced doses of benzimidazole carbamates, if at all.[2]

1. Morris DL, Smith PG. Albendazole in hydatid disease—hepatocellular toxicity. *Trans R Soc Trop Med Hyg* 1987; **81:** 343–4.
2. Davis A, *et al.* Multicentre clinical trials of benzimidazolecarbamates in human cystic echinococcosis (phase 2). *Bull WHO* 1989; **67:** 503–8.

Pregnancy. Albendazole is teratogenic in some *animals* and there are no adequate and well controlled studies in human pregnancy. Albendazole is therefore usually contra-indicated during pregnancy and licensed product information cautions against becoming pregnant while taking albendazole or within one month of completing treatment.

Interactions

Anthelmintics. The plasma concentration of albendazole sulfoxide has been increased by *praziquantel*,[1] although the practical consequences of this were considered uncertain.

1. Homeida M, *et al.* Pharmacokinetic interaction between praziquantel and albendazole in Sudanese men. *Ann Trop Med Parasitol* 1994; **88:** 551–9.

Antiepileptics. *Phenytoin*, *carbamazepine*, and *phenobarbital* appear to induce the oxidative metabolism of albendazole via the cytochrome P450 isoenzyme CYP3A by roughly the same extent, resulting in significantly reduced concentrations of albendazole sulfoxide. This interaction is likely to be clinically significant when albendazole is used to treat systemic worm infections, and increased doses of albendazole would be needed.[1] The interaction is probably not clinically significant when albendazole is used for intestinal worm infections.

1. Lanchote VL, *et al.* Pharmacokinetic interaction between albendazole sulfoxide enantiomers and antiepileptic drugs in patients with neurocysticercosis. *Ther Drug Monit* 2002; **24:** 338–45.

Corticosteroids. Plasma concentrations of the active metabolite of albendazole (albendazole sulfoxide) were reported to be raised by about 50% in a study in 8 patients receiving *dexamethasone*.[1]

1. Jung H, *et al.* Dexamethasone increases plasma levels of albendazole. *J Neurol* 1990; **237:** 279–80.

Histamine H_2-antagonists. Concentrations of albendazole sulfoxide have been found to be raised in bile and hydatid cyst fluid when albendazole was given with *cimetidine*, which may increase effectiveness in the treatment of echinococcosis.[1]

1. Wen H, *et al.* Initial observation on albendazole in combination with cimetidine for the treatment of human cystic echinococcosis. *Ann Trop Med Parasitol* 1994; **88:** 49–52.

Pharmacokinetics

Absorption of albendazole from the gastrointestinal tract is poor but may be enhanced by a fatty meal. Albendazole rapidly undergoes extensive first-pass metabolism. Its principal metabolite albendazole sulfoxide has anthelmintic activity and a plasma half-life of about 8.5 hours. Albendazole sulfoxide is widely distributed throughout the body including into the bile and the CSF. It is about 70% bound to plasma protein. Albendazole sulfoxide is eliminated in the bile; only a small amount appears to be excreted in the urine.

◊ References.

1. Marriner SE, *et al*. Pharmacokinetics of albendazole in man. *Eur J Clin Pharmacol* 1986; **30:** 705–8.
2. Morris DL, *et al.* Penetration of albendazole sulphoxide into hydatid cysts. *Gut* 1987; **28:** 75–80.
3. Steiger U, *et al.* Albendazole treatment of echinococcosis in humans: effects on microsomal metabolism and drug tolerance. *Clin Pharmacol Ther* 1990; **47:** 347–53.
4. Jung H, *et al.* Clinical pharmacokinetics of albendazole in patients with brain cysticercosis. *J Clin Pharmacol* 1992; **32:** 28–31.
5. Jung H, *et al.* Clinical pharmacokinetics of albendazole in children with neurocysticercosis. *Am J Ther* 1997; **4:** 23–6.

Uses and Administration

Albendazole is a benzimidazole carbamate anthelmintic structurally related to mebendazole (p.148) and with similar activity. It is used in relatively high doses in the treatment of the cestode infections cysticercosis and echinococcosis (hydatid disease). In some countries albendazole is used in the treatment of single and mixed intestinal nematode infections including ascariasis, enterobiasis, hookworm, strongyloidiasis, and trichuriasis. It may also be used in the treatment of angiostrongyliasis, capillariasis, gnathostomiasis, and trichostrongyliasis. Albendazole may be effective in the treatment of the tissue nematode infections cutaneous larva migrans, toxocariasis, and trichinosis and has been tried in loiasis, and, with other anthelmintics, in mass treatment programmes in areas where lymphatic filariasis is endemic. For discussions of these infections and their treatment, see under Choice of Anthelmintic (p.134), and under the individual headings below.

In the treatment of **echinococcosis**, albendazole is given orally with meals in a dose of 400 mg twice daily for 28 days for patients weighing over 60 kg. A dose of 15 mg/kg daily in two divided doses (to a maximum total daily dose of 800 mg) is used for patients weighing less than 60 kg. For cystic echinococcosis, the 28-day course may be repeated after 14 days without treatment to a total of 3 treatment cycles. For alveolar echinococcosis, cycles of 28 days of treatment followed by 14 days without treatment may need to continue for months or years.

In the treatment of **neurocysticercosis**, US licensed product information recommends doses of albendazole for parenchymal cysts similar to the doses used in echinococcosis (see above); the recommended duration of treatment is 8 to 30 days. Current expert opinion also favours similar doses of 15 mg/kg daily but with a duration of treatment of only 8 days for parenchymal disease and about 1 month for subarachnoid disease. For further information on dosage regimens, see Cysticercosis, below.

Albendazole is given orally, usually as a single dose, in the treatment of single or mixed **intestinal nematode infections**. The usual dose for adults and children aged 2 years or over with ascariasis, enterobiasis, hookworm infections, or trichuriasis is 400 mg as a single dose. In enterobiasis, the dose may be repeated in 1 to 4 weeks. Some consider that children of 1 to 2 years of age may be given 200 mg for enterobiasis. In strongyloidiasis, 400 mg is given once or twice daily for 3 consecutive days; this may be repeated after 3 weeks if necessary.

Albendazole has also been used to treat **giardiasis** (p.824); suggested doses are 400 mg daily by mouth for 5 days.

Ascariasis. Albendazole is used as an alternative to mebendazole in the treatment of ascariasis (p.134). Both drugs are equally highly effective with a cure rate greater than 98% reported for albendazole in one study.[1]

1. Albonico M, *et al.* A randomized controlled trial comparing mebendazole and albendazole against Ascaris, Trichuris and hookworm infections. *Trans R Soc Trop Med Hyg* 1994; **88:** 585–9.

Capillariasis. Albendazole in a dose of 400 mg daily for 10 days has been suggested[1] as an alternative to mebendazole for the treatment of capillariasis (p.135).

1. Abramowicz M, ed. *Drugs for parasitic infections*. 1st ed. New Rochelle NY: The Medical Letter, 2007.

Cutaneous larva migrans. Albendazole has been reported[1-4] to be effective in the treatment of cutaneous larva migrans (p.135) and is an alternative to tiabendazole or ivermectin. Albendazole, generally in a dose of 400 mg daily for three[1] or five[2] days, has alleviated the discomfort of cutaneous larva migrans; treatment for seven days may be more effective and has not been associated with an increased incidence of adverse effects.[4] A single dose of 400 mg has also been effective.[3] An ointment containing albendazole 10%, applied 3 times a day for 10 days, was reported to be effective in treating cutaneous larva migrans in 2 young children.[5]

1. Jones SK, *et al.* Oral albendazole for the treatment of cutaneous larva migrans. *Br J Dermatol* 1990; **122:** 99–101.
2. Sanguigni S, *et al.* Albendazole in the therapy of cutaneous larva migrans. *Trans R Soc Trop Med Hyg* 1990; **84:** 831.
3. Oriheula AR, Torres JR. Single dose of albendazole in the treatment of cutaneous larva migrans. *Arch Dermatol* 1990; **126:** 398–9.
4. Veraldi S, Rizzitelli G. Effectiveness of a new therapeutic regimen with albendazole in cutaneous larva migrans. *Eur J Dermatol* 1999; **9:** 352–3.
5. Caumes E. Efficacy of albendazole ointment on cutaneous larva migrans in 2 young children. *Clin Infect Dis* 2004; **38:** 1647–8.

Cysticercosis. The use of anthelmintics in the treatment of neurocysticercosis (see Cysticercosis, p.135) remains controversial, but if indicated albendazole is considered to be the drug of choice.[1-3] The dose of albendazole originally used was the same as that used in echinococcosis, typically about 15 mg/kg daily orally for 1 month. There is now some evidence that shorter courses of treatment may be appropriate in some forms of neurocysticercosis. A study[4] confirmed that a 10-day course of albendazole 400 mg twice daily, together with dexamethasone, was safe and decreased the burden of parasites and the number of generalised seizures in patients with viable parenchymal cysts. Albendazole has also been reported to be effective for extraparenchymal infection, such as subarachnoid, ventricular,[2,5,6] and spinal cord cysticercosis,[2] but the longer treatment period of 1 month with a dose of 15 mg/kg daily is usually used. Alternatively, a higher dose of albendazole for a shorter time may be considered. A study[5] of 36 patients with subarachnoid and intraventricular cysticercosis found that 30 mg/kg daily for 8 days was safe and more effective than 15 mg/kg daily for 8 days, both regimens being given with corticosteroids.

1. Sotelo J, Jung H. Pharmacokinetic optimisation of the treatment of neurocysticercosis. *Clin Pharmacokinet* 1998; **34:** 503–15.
2. Takayanagui OM. Therapy for neurocysticercosis. *Expert Rev Neurother* 2004; **4:** 129–39.
3. Del Brutto OH, *et al.* Meta-analysis: cysticidal drugs for neurocysticercosis: albendazole and praziquantel.*Ann Intern Med* 2006; **145:** 43–51.
4. Garcia HH, *et al.* A trial of antiparasitic treatment to reduce the rate of seizures due to cerebral cysticercosis. *N Engl J Med* 2004; **350:** 249–58.
5. Góngora-Rivera F, *et al.* Albendazole trial at 15 or 30 mg/kg/day for subarachnoid and intraventricular cysticercosis. *Neurology* 2006; **66:** 436–8.
6. Proaño JV, *et al.* Medical treatment for neurocysticercosis characterized by giant subarachnoid cysts. *N Engl J Med* 2001; **345:** 879–85.

Echinococcosis. Albendazole is used in the treatment of echinococcosis (p.136) as an adjunct to, or instead of, surgery. It is generally preferred to mebendazole.

References.

1. Teggi A, *et al.* Therapy of human hydatid disease with mebendazole and albendazole. *Antimicrob Agents Chemother* 1993; **37:** 1679–84.
2. Gil-Grande LA, *et al.* Randomised controlled trial of efficacy of albendazole in intra-abdominal hydatid disease. *Lancet* 1993; **342:** 1269–72.
3. Wen H, *et al.* Initial observation on albendazole in combination with cimetidine for the treatment of human cystic echinococcosis. *Ann Trop Med Parasitol* 1994; **88:** 49–52.
4. Wen H, *et al.* Albendazole chemotherapy for human cystic and alveolar echinococcosis in north-western China. *Trans R Soc Trop Med Hyg* 1994; **88:** 340–3.
5. Liu Y, *et al.* Continuous long-term albendazole therapy in intraabdominal cystic echinococcosis. *Chin Med J (Engl)* 2000; **113:** 827–32.
6. Keshmiri M, *et al.* Albendazole versus placebo in treatment of echinococcosis. *Trans R Soc Trop Med Hyg* 2001; **95:** 190–4.
7. Falagas ME, Bliziotis IA. Albendazole for the treatment of human echinococcosis: a review of comparative clinical trials. *Am J Med Sci* 2007; **334:** 171–9.

Gnathostomiasis. Albendazole has been reported to be effective in the treatment of gnathostomiasis (p.136). Doses of 400 mg once or twice daily have been given for 2 or 3 weeks.[1-4]

1. Kraivichian P, *et al.* Albendazole for the treatment of human gnathostomiasis. *Trans R Soc Trop Med Hyg* 1992; **86:** 418–21.
2. Suntharasamai P, *et al.* Albendazole stimulates outward migration of Gnathostoma spinigerum to the dermis in man. *Southeast Asian J Trop Med Public Health* 1992; **23:** 716–22.
3. Nontasut P, *et al.* Comparison of ivermectin and albendazole treatment for gnathostomiasis. *Southeast Asian J Trop Med Public Health* 2000; **31:** 374–7.
4. Abramowicz M, ed. *Drugs for parasitic infections*. 1st ed. New Rochelle NY: The Medical Letter, 2007.

Hookworm infections. Hookworm infections (p.136) are commonly treated with benzimidazole carbamates such as albendazole. In 77 patients with light necatoriasis (*Necator americanus* infection) albendazole, in a single 400-mg dose, produced an 84% cure rate and an 82% reduction in egg count in those patients not cured.[1] In another study,[2] although the cure rate was only 56.8% after a single 400-mg dose of albendazole this was superior to treatment with mebendazole which had a cure rate of 22.4%. A further study[3] comparing albendazole with mebendazole and pyrantel in the treatment of necatoriasis also found albendazole to be the most effective.

Albendazole is given in mass treatment programmes to reduce the overall burden of infection.[1,4]

1. Nahmias J, *et al.* Evaluation of albendazole, pyrantel, bephenium, pyrantel-praziquantel and pyrantel-bephenium for single-dose mass treatment of necatoriasis. *Ann Trop Med Parasitol* 1989; **83:** 625–9.
2. Albonico M, *et al.* A randomized controlled trial comparing mebendazole and albendazole against Ascaris, Trichuris and hookworm infections. *Trans R Soc Trop Med Hyg* 1994; **88:** 585–9.
3. Sacko M, *et al.* Comparison of the efficacy of mebendazole, albendazole and pyrantel in treatment of human hookworm infections in the southern region of Mali, West Africa. *Trans R Soc Trop Med Hyg* 1999; **93:** 195–203.
4. Idris MA, *et al.* Effective control of hookworm infection in school children from Dhofar, Sultanate of Oman: a four-year experience with albendazole mass chemotherapy. *Acta Trop* 2001; **80:** 139–43.

Loiasis. Albendazole has been investigated[1,2] to reduce microfilariasis in patients infected with *Loa loa* (see Loiasis, p.137) with modest success.

1. Klion AD, *et al.* Albendazole in human loiasis: results of a double-blind, placebo-controlled trial. *J Infect Dis* 1993; **168:** 202–6.
2. Tabi TE, *et al.* Human loiasis in a Cameroonian village: a double-blind, placebo-controlled, crossover clinical trial of a three-day albendazole regimen. *Am J Trop Med Hyg* 2004; **71:** 211–15.

Lymphatic filariasis. Albendazole is used in the management of lymphatic filariasis (p.137). In endemic areas mass treatment of the entire population (excluding neonates, pregnant women, and debilitated individuals) can reduce the intensity of transmission and the incidence of disease. The Global Programme to eliminate Lymphatic Filariasis launched by WHO, with other international agencies, advocates a single dose of albendazole 400 mg with either a single dose of ivermectin 150 to 200 micrograms/kg (if there is co-endemic loiasis or onchocerciasis) or with a single dose of diethylcarbamazine 6 mg/kg (if there is no co-endemic loiasis or onchocerciasis); these doses are given once each year for at least 5 years.

Microsporidiosis. Albendazole has been tried[1-6] in the treatment of the protozoal infection microsporidiosis (p.826) in patients with AIDS. Albendazole has also been used empirically in the treatment of HIV-associated infections and complications (p.857).

1. Blanshard C, *et al.* Treatment of intestinal microsporidiosis with albendazole in patients with AIDS. *AIDS* 1992; **6:** 311–13.
2. Dieterich DT, *et al.* Treatment with albendazole for intestinal disease due to Enterocytozoon bieneusi in patients with AIDS. *J Infect Dis* 1994; **169:** 178–82.
3. Franzen C, *et al.* Intestinal microsporidiosis with Septata intestinalis in a patient with AIDS—response to albendazole. *J Infect* 1995; **31:** 237–9.
4. Dore GJ, *et al.* Disseminated microsporidiosis due to Septata intestinalis in nine patients infected with the human immunodeficiency virus: response to therapy with albendazole. *Clin Infect Dis* 1995; **21:** 70–6.
5. Molina J-M, *et al.* Albendazole for treatment and prophylaxis of microsporidiosis due Encephalitozoon intestinalis in patients with AIDS: a randomized double-blind controlled trial. *J Infect Dis* 1998; **177:** 1373–7.
6. Tremoulet AH, *et al.* Albendazole therapy for Microsporidium diarrhea in immunocompetent Costa Rican children. *Pediatr Infect Dis J* 2004; **23:** 915–18.

Strongyloidiasis. Albendazole is generally preferred to tiabendazole or mebendazole in the treatment of strongyloidiasis (p.138) although ivermectin is now generally considered to be the drug of choice. Both drugs have been used together in disseminated disease.

References.

1. Rossignol JF, Maisonneuve H. Albendazole: placebo-controlled study in 870 patients with intestinal helminthiasis. *Trans R Soc Trop Med Hyg* 1983; **77:** 707–11.
2. Chanthavanich P, *et al.* Repeated doses of albendazole against strongyloidiasis in Thai children. *Southeast Asian J Trop Med Public Health* 1989; **20:** 221–6.
3. Mojon M, Nielsen PB. Treatment of Strongyloides stercoralis with albendazole: a cure rate of 86 per cent. *Zentralbl Bakteriol Mikrobiol Hyg [A]* 1987; **263:** 619–24.

4. Archibald LK, *et al.* Albendazole is effective treatment for chronic strongyloidiasis. *Q J Med* 1993; **86:** 191–5.
5. Pornsuriyasak P, *et al.* Disseminated strongyloidiasis successfully treated with extended duration ivermectin combined with albendazole: a case report of intractable strongyloidiasis. *Southeast Asian J Trop Med Public Health* 2004; **35:** 531–4.
6. Singthong S, *et al.* Randomized comparative trial of two high-dose albendazole regimens for uncomplicated human strongyloidiasis. *Southeast Asian J Trop Med Public Health* 2006; **37** (suppl 3): 32–4.

Toxocariasis. Albendazole is one of the drugs that might be used for the treatment of toxocariasis (p.139) and in a small study[1] it produced improvement similar to that achieved with tiabendazole but with fewer problems.

1. Stürchler D, *et al.* Thiabendazole vs albendazole in treatment of toxocariasis: a clinical trial. *Ann Trop Med Parasitol* 1989; **83:** 473–8.

Trichinosis. Albendazole may be effective in the treatment of trichinosis (p.139). A retrospective study in 44 patients with trichinosis comparing albendazole treatment with tiabendazole found that, while the two drugs were of comparable efficacy, albendazole was the better tolerated.[1] Albendazole has been used to treat a patient infected with *Trichinella pseudospiralis*, an organism related to *T. spiralis*, the usual cause of trichinosis.[2]

1. Cabié A, *et al.* Albendazole versus thiabendazole as therapy for trichinosis: a retrospective study. *Clin Infect Dis* 1996; **22:** 1033–5.
2. Andrews JRH, *et al.* Trichinella pseudospiralis in humans: description of a case and its treatment. *Trans R Soc Trop Med Hyg* 1994; **88:** 200–3.

Trichostrongyliasis. Albendazole in a single dose of 400 mg has been suggested[1] as an alternative to pyrantel embonate or mebendazole in the treatment of trichostrongyliasis (p.139).

1. Abramowicz M, ed. *Drugs for parasitic infections*. 1st ed. New Rochelle NY: The Medical Letter, 2007.

Trichuriasis. Albendazole is used in the treatment of trichuriasis (p.139). It is normally given in a single dose and is often used in mixed intestinal nematode infections.[1] However, it has been reported[1-3] that in children with mixed intestinal worm infections single doses of albendazole are ineffective in eliminating *Trichuris trichiura* and multiple doses are required to produce worthwhile reductions in egg production. Treatment for 3 days has been used[4] (but for a suggestion that such regimens may be associated with impaired growth in less heavily infected children, see Effects on Growth under Adverse Effects, above). Combined use of albendazole with ivermectin may prove useful.[5]

1. Hall A, Anwar KS. Albendazole and infections with Trichuris trichiura and Giardia intestinalis. *Southeast Asian J Trop Med Public Health* 1991; **22:** 84–7.
2. Hall A, Nahar Q. Albendazole and infections with Ascaris lumbricoides and Trichuris trichiura in children in Bangladesh. *Trans R Soc Trop Med Hyg* 1994; **88:** 110–12.
3. Albonico M, *et al.* A randomized controlled trial comparing mebendazole and albendazole against Ascaris, Trichuris and hookworm infections. *Trans R Soc Trop Med Hyg* 1994; **88:** 585–9.
4. Abramowicz M, ed. *Drugs for parasitic infections*. 1st ed. New Rochelle NY: The Medical Letter, 2007.
5. Ismail MM, Jayakody RL. Efficacy of albendazole and its combinations with ivermectin or diethylcarbamazine (DEC) in the treatment of Trichuris trichiura infections in Sri Lanka. *Ann Trop Med Parasitol* 1999; **93:** 501–4.

Preparations

USP 31: Albendazole Tablets.

Proprietary Preparations (details are given in Part 3)

Arg.: Vastus; ***Austral.:*** Eskazole; Zentel; ***Austria:*** Eskazole; ***Braz.:*** Alba-3; Albel; Alben†; Albendrox†; Albendy†; Albenix†; Albentel; Albenzonil; Albezin†; Alib†; Alin; Alzoben†; Bentiamin†; Benzol; Imavermil; Mebenix; Monozol; Neo Bendazol; Parasin; Parazol; Totelmin†; Verdazol†; Vermiclase; Vermital; Zentel; Zolben; Zoldan†; ***Chile:*** Ceprazol; Vermoil; Zentel; ***Cz.:*** Zentel; ***Fr.:*** Zentel; ***Ger.:*** Eskazole; ***Gr.:*** Eskazole; Zentel; ***India:*** Albezole; Bendex; Combantrin-A; Emanthal; Nemozole; Olworm; Zentel; ***Israel:*** Eskazole; ***Ital.:*** Zentel; ***Malaysia:*** Albendol; Champs D-Worms; Thelban†; Vemizol; Zentel; Zoben; ***Mex.:*** Albensil; Aldamin; Alfazol; Bendapar; Bradelmin; Dazocan; Dazolin; Dezabil; Digezanol; Entoplus; Eskazole; Euralben; Flatezol†; Gascop; Helmisons; Kolexan; Loveral; Lurdex; Olbendital; Rivazol; Serbendazol; Synparyn; Tenibex; Veranzol; Vermilan†; Vermin Plus; Vermisen; Zelfin; Zenaxin; Zentel; ***Neth.:*** Eskazole; ***Philipp.:*** Zentel; ***Pol.:*** Zentel; ***Port.:*** Zentel; ***Rus.:*** Nemozole (Немозол); ***S.Afr.:*** Bendex; Zentel; ***Singapore:*** Alzental; Zentel; ***Spain:*** Eskazole; ***Switz.:*** Zentel; ***Thai.:*** Abentel; Albatel; Alben; Albenda; Alda†; Alfuca; Alzol; Anthel†; Gendazel; Labenda; Leo-400; Manoverm; Masaworm†; Mesin; Mycotel; Vermixide; Zeben; Zela; Zentel; Zenzera; ***Turk.:*** Andazol; ***UAE:*** Albenda; ***USA:*** Albenza; ***Venez.:*** Albezol; Albicar; Bevindazol; Helal; Sostril; Taron; Vendazol; Zentel.

Multi-ingredient: ***Mex.:*** Oxal.

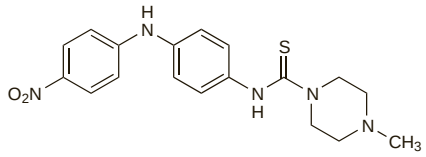
Amocarzine *(rINN)*

Amocarzina; Amocarzinum; CGP-6140. 4-Methyl-4′-(*p*-nitroanilino)thio-1-piperazinecarboxanilide.

Амокарзин

$C_{18}H_{21}N_5O_2S$ = 371.5.

CAS — 36590-19-9.



NOTE. Amocarzine has sometimes been referred to as thiocarbamazine.

Profile

Amocarzine is an antifilarial anthelmintic that is active against the adult worms of *Onchocerca volvulus.* It has been studied for the oral treatment of onchocerciasis (p.137).

◊ References.

1. Poltera AA, *et al.* Onchocercacidal effects of amocarzine (CGP 6140) in Latin America. *Lancet* 1991; **337:** 583–4.
2. Cooper PJ, *et al.* Onchocerciasis in Ecuador: evolution of chorioretinopathy after amocarzine treatment. *Br J Ophthalmol* 1996; **80:** 337–42.
3. Awadzi K, *et al.* The safety and efficacy of amocarzine in African onchocerciasis and the influence of ivermectin on the clinical and parasitological response to treatment. *Ann Trop Med Parasitol* 1997; **91:** 281–96.

Trivalent Antimony Compounds

Compuestos de antimonio trivalente.

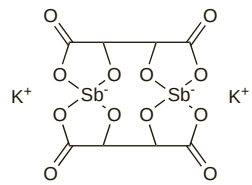
Antimony Potassium Tartrate

Antim. Pot. Tart.; Antimónico potásico, tartrato; Antymonu potasu winian; Brechweinstein; Kalii Stibyli Tartras; Potassium Antimonyltartrate; Stibii et Kalii Tartras; Tartar Emetic; Tartarus Stibiatus. Dipotassium bis{μ-[2,3-dihydroxybutanedioato(4-)-O^1,O^2:O^3,O^4]}-diantimonate(2-) trihydrate; Dipotassium bis[μ-tartrato(4-)]diantimonate(2-) trihydrate.

Антимонил-тартрат Калия

$C_8H_4K_2O_{12}Sb_2,3H_2O$ = 667.9.

CAS — 11071-15-1 (anhydrous antimony potassium tartrate); 28300-74-5 (antimony potassium tartrate trihydrate).



Pharmacopoeias. In *US*.

USP 31 (Antimony Potassium Tartrate). Odourless, colourless, transparent crystals or white powder. The crystals effloresce on exposure to air and do not readily rehydrate even on exposure to high humidity. Soluble 1 in 12 of water, 1 in 3 of boiling water, and 1 in 15 of glycerol; insoluble in alcohol. Its solutions are acid to litmus.

Antimony Sodium Tartrate

Antim. Sod. Tart.; Antimónico sódico, tartrato; Sodium Antimonyltartrate; Stibium Natrium Tartaricum. Disodium bis{μ-[2,3-dihydroxybutanedioato(4-)-O^1,O^2:O^3,O^4]}diantimonate(2-); Disodium bis{μ-[L-(+)-tartrato(4-)]}diantimonate(2-).

Антимонил-тартрат Натрия

$C_8H_4Na_2O_{12}Sb_2$ = 581.6.

CAS — 34521-09-0.

Pharmacopoeias. In *Int.* (as $C_4H_4NaO_7Sb$ = 308.8) and *US*.

USP 31 (Antimony Sodium Tartrate). Odourless, colourless, transparent crystals or white powder. The crystals effloresce on exposure to air. Freely soluble in water; insoluble in alcohol.

Sodium Stibocaptate *(BAN, rINN)*

Antimony Sodium Dimercaptosuccinate; Estibocaptato de sodio; Natrii Stibocaptas; Ro-4-1544/6; Sb-58; Stibocaptate; Stibocaptate de Sodium; TWSb/6. Antimony sodium *meso*-2,3-dimercaptosuccinate. The formula varies from $C_{12}H_{11}NaO_{12}S_6Sb_2$ = 806.1 to $C_{12}H_6Na_6O_{12}S_6Sb_2$ = 916.0.

Натрия Стибокаптат

CAS — 3064-61-7 ($C_{12}H_6Na_6O_{12}S_6Sb_2$).

Stibophen

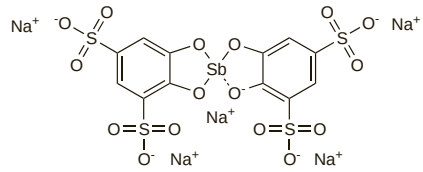
Estibofeno; Fouadin; Stibophenum. Bis[4,5-dihydroxybenzene-1,3-disulphonato(4–)-O^4,O^5]antimonate(5–) pentasodium heptahydrate.

Стибофен

$C_{12}H_4Na_5O_{16}S_4Sb,7H_2O$ = 895.2.

CAS — 15489-16-4 (stibophen heptahydrate).

ATC — P02BX03.



Adverse Effects and Treatment

Trivalent antimony compounds are more toxic than pentavalent antimonials such as sodium stibogluconate, possibly because they are excreted much more slowly. The most serious adverse effects are on the heart and liver. There are invariably ECG changes during treatment, but hypotension, bradycardia, and cardiac arrhythmias are more serious. Sudden death or cardiovascular collapse may occur at any time. Elevated liver enzyme values are common; liver damage with hepatic failure and death is more likely in patients with pre-existing hepatic disease.

Adverse effects immediately after intravenous use of trivalent antimonials, in particular the tartrates, have included coughing, chest pain, pain in the arms, vomiting, abdominal pain, fainting, and collapse, especially after rapid injection. Extravasation during injection is extremely painful because of tissue damage. An anaphylactoid reaction characterised by an urticarial rash, husky voice, and collapse has been reported after the sixth or seventh intravenous injection of a course of treatment.

Numerous less immediate adverse effects have occurred including gastrointestinal disturbances, muscular and joint pains, arthritis, pneumonia, dyspnoea, headache, dizziness, weakness, pruritus, skin rashes, facial oedema, fever, haemolytic anaemia, and kidney damage.

Large oral doses of antimony compounds have an emetic action. Continuous treatment with small doses of antimony may give rise to symptoms of subacute poisoning similar to those of chronic arsenical poisoning.

Treatment of severe poisoning with antimony compounds is similar to that for arsenic poisoning (p.2261); dimercaprol may be of benefit.

◊ References.

1. Stemmer KL. Pharmacology and toxicology of heavy metals: antimony. *Pharmacol Ther* 1976; **1:** 157–60.

Precautions

Trivalent antimony therapy has generally been superseded by less toxic treatment. It is contra-indicated in the presence of lung, heart, liver, or kidney disease. Intravenous injections should be given very slowly and stopped if coughing, vomiting, or substernal pain occurs; extravasation should be avoided.

Some antimony compounds such as the tartrates cause severe pain and tissue necrosis and should not be given by intramuscular or subcutaneous injection.

Breast feeding. The American Academy of Pediatrics[1] states that there have been no reports of any clinical effect on the infant associated with the use of antimony by breast-feeding mothers, and that therefore it may be considered to be usually compatible with breast feeding.

1. American Academy of Pediatrics. The transfer of drugs and other chemicals into human milk. *Pediatrics* 2001; **108:** 776–89. Correction. *ibid.*; 1029. Also available at: http://aappolicy.aappublications.org/cgi/content/full/pediatrics%3b108/3/776 (accessed 02/06/04)

Glucose-6-phosphate dehydrogenase deficiency. In the event of trivalent antimony compounds being used, patients with G6PD deficiency should be excluded. WHO lists stibophen[1] among the anthelmintics to be avoided in patients with this deficiency.

1. WHO. Glucose-6-phosphate dehydrogenase deficiency. *Bull WHO* 1989; **67:** 601–11.

Pharmacokinetics

Antimony compounds are poorly absorbed from the gastrointestinal tract. They are slowly excreted, mainly in the urine, after parenteral doses. Antimony accumulates in the body during treatment and persists for several months afterwards. Trivalent antimony has a greater affinity for cell proteins than for plasma proteins.

Uses and Administration

Trivalent antimony compounds were used in the treatment of the protozoal infection leishmaniasis until the advent of the less toxic pentavalent compounds. They continued to be used in the treatment of schistosomiasis, but have now been superseded by less toxic and more easily given drugs such as praziquantel.